

Complicated Type B Aortic Dissection in Late Pregnancy: Management Strategy and Outcomes

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Abstract

Objective: Pregnancy with complicated type B aortic dissection is a rare but devastating scenario. And there are no definitive guidelines for management and therapy. We report our exploration and experiences of managing five pregnant with complicated TBAD in the second or third trimesters, aiming to propose an appropriate management strategy. **Design:** Retrospective study. **Setting:** Zhongnan Hospital of Wuhan University. **Population:** Pregnant women with TBAD **Methods:** The clinical data of 5 pregnant women with TBAD who were admitted to the Zhongnan Hospital of Wuhan University from January 2022 to June 2023 were collected. The clinical features, diagnostic procedures, treatment strategies and corresponding maternal and infant outcomes were retrospectively analyzed. **Main Outcome Measures:** The survival of mother and fetus. **Result:** All five pregnant women with TBAD were diagnosed with complicated TBAD. The average age of the patients was (34.8 ± 8.13) years, and the range of gestational weeks at admission was 27 weeks plus 3 days to 36 weeks plus 6 days. The first patient intending to receive a cesarean section and subsequent TEVAR died of rupture of aortic dissection during cesarean section. Her neonate was successfully rescued. The remaining four patients who underwent TEVAR first survived. Three underwent single-stage aortic repair and delivery, and one patient underwent cesarean section 27 days after TEVAR. Three preterm live births of these four patients were recorded. During late follow-up, no maternal and fetal deaths occurred. Neither device-related nor systemic complications post TEVAR were observed in the mother. Routine physical examinations of four live births showed no abnormalities. **Conclusion:** When a pregnant woman in the second or third trimester has thoracic back pain and highly suspected aortic dissection, CTA should be performed to avoid missed diagnosis, misdiagnosis and diagnostic delay. Once diagnosed, maternal survival should be prioritized over fetal concerns. TEVAR is safe and feasible for such patients. For complicated TBAD in the third trimester single-stage delivery and TEVAR are preferred, and TEVAR followed by cesarean section performed in one operative session is the treatment of choice.

Introduction

Aortic dissection (AD) in pregnancy is a rare and life-threatening complication. Data from the International Registry of Acute Aortic Dissection showed that aortic dissection in pregnancy accounts for 0.0004% of all pregnancies, and 0.1% to 0.4% of all aortic dissection¹. Although, it was reported that pregnancy with type B aortic dissection (TBAD) accounts for 11% to 21% of this disease². The incidence of TBAD during pregnancy and puerperium rose from 2002 to 2017 based on the data from the National Inpatient Sample (NIS) database of the United States³. Moreover, it was surprising that the hospital mortality of TBAD group was higher than that of type A AD (TAAD) group. In addition, it was reported that fetal outcomes were worse in TBAD group due to possible involvement of the iliac arteries⁴. Despite the elevated incidence and serious hazard of pregnant with TBAD, the optimal management strategy for this disease remains controversial and undetermined.

For TBAD in pregnancy, current treatment experience is still insufficient and primarily based on case reports and small case series. TBAD can be divided into complicated and uncomplicated according to clinical fea-

tures and disease severity. Uncomplicated TBAD is usually recommended to be treated medically, while complicated TBAD is preferably treated with thoracic endovascular aortic repair (TEVAR). The success rate of TEVAR for TBAD in unpregnant people was reported as high as 97.66% to 99.20%⁵. However, its effectiveness and safety in TBAD in pregnancy remains uncertain especially taken fetus life into consideration in late gestation. Therefore, it is necessary to explore the optimal treatment strategy for patients with TBAD in late pregnancy. This article summarized the data of five cases with complicated TBAD in late pregnancy at our center and analyzed the corresponding maternal and fetal outcomes. The aim of this study is to investigate an optimal management strategy of pregnant with complicated type B aortic dissection during the late second or third trimesters.

Methods

Study design

We retrospectively reviewed medical records from five pregnant women with complicated TBAD admitted to Zhongnan Hospital of Wuhan University from Jan 2022 to Jun 2023. Stanford classification was adopted in the study, and TBAD refers to the absence of involvement of the ascending aorta. Complicated TBAD is defined as the presence of malperfusion syndrome or rupture. Diagnosis of complicated TBAD was based on clinical features and CT angiography (CTA) according to the Society of Thoracic Surgeons/American Association for thoracic surgery clinical practice guidelines on the management of TBAD⁶. This study was reviewed and approved by the Medical Ethical Committee of Zhongnan Hospital of Wuhan University (approval number 2023216K). Obtaining patient consent was not required according to the committee's procedures.

Treatment

Patients were admitted to the hospital through emergency or referral. After admission, multiple departments, including obstetrics, anesthesiology, cardiovascular surgery, pediatrics and intensive care unit (ICU), joined to formulate combined treatment schemes. The safety of both mother and fetus was considered, which mother's safety was given priority. According to the patient's condition, low flow oxygen inhalation and drugs for pain relief and sedation were given. Medications were used to maintain systolic blood pressure between 100 and 120 mmHg⁷, to limit the extension of the dissection and reduce the risk of developing end-organ damage and rupture⁸. The status of the fetus was monitored by ultrasound and fetal heart electronic monitoring.

All five patients were planned to perform TEVAR and terminate pregnancy through cesarean section. The timing and method of surgery were determined by the patient's condition, gestational age and comorbidities. Cesarean section might be conducted before, immediately after, or for a period after TEVAR. For patients planning to experience TEVAR first, the times of arterial imaging should be minimized as much as possible, and the surgery should be finished within a short time to reduce the impact of radiation exposure and general anesthesia on the fetus. For patients undergoing cesarean section, abdominal pressure and uterotonics should be avoided to minimize the impact on the cardiovascular system and fluctuations of the hemodynamic. Uterine artery ligation should be used to prevent postpartum hemorrhage. Infants were resuscitated by neonatologists according to the Neonatal Resuscitation Program guidelines. For patients who have not terminated pregnancy yet, the status of the fetus should be monitored intensively.

Follow up

The patients were followed up for at least three months after discharge. For mothers, blood routine, coagulation, and other tests were examined every week after discharge for one month and then detected every month. CTA testing was performed at one month, six months, 12 months, and then yearly after discharge to monitor the condition of the affected arteries and detect any postoperative complications⁷. For newborns, the growth and development of infants were monitored by pediatricians.

Data collection

Socio-demographic variables of patients were collected, including age, gestation weeks, clinical manifestati-

on, comorbidities, gravidity history and medical history. Laboratory and imaging examination results were obtained from medical record. The treatment process was recorded in detail. Primary outcomes are the survival of mother and fetus. Secondary outcomes are the completion of coated stent-graft implantation, the changes in the size of true and false lumens of aortic dissection, and the occurrence of postoperative complications, including endoleaks, endograft migration, graft infection, end-organ ischemia, cerebrovascular and cardiovascular events and post-implantation syndrome.

Results

Clinical and laboratory characteristics

The clinical and laboratory characteristics of patients are summarized in Table 1. All patients had complicated TBAD. The age range of the patients was 27 to 44 years, and the range of gestational weeks at admission was 27 weeks plus three days to 36 weeks plus six days. Among these patients, none of them had diabetes, chronic hypertension, connective tissue disorder, or cardiovascular disease before pregnancy. However, three patients developed pre-eclampsia during pregnancy. In addition, all patients were multipara and had a history of cesarean section. All five patients presented with severe chest pain and/or back pain. Since the occurrence of thoracic back pain, three patients showed elevated blood pressure, and two of them had refractory hypertension. All patient has asymmetric blood pressure. Only one patient had a cardiac function rating of III, while the other three patients had a cardiac function rating of II. Additionally, one patient had signs of threatened premature delivery, including uterine contraction and cervical shortening.

All five patients had a CTA test after admission and showed typical signs of complicated TBAD (Figure 1). Three patients' lesions were evaluated from the aortic arch. In contrast, the lesion formation of another two patients started distal to the left subclavian artery. Three patients had imaging evidence of malperfusion, mainly manifested as extensive arterial involvement, including the renal artery, celiac trunk, and superior mesenteric artery. The range of aortic width was 18.57-31.35mm. One patient's cardiac ultrasound showed aortic regurgitation and aneurysmal dilatation of the aortic sinus. Data from laboratory tests showed that four of the five patients had elevated level of D-Dimer, with an average of (719 ± 243.79) ng/L. Four patients had increased lymphocyte ratio (mean value: $86.74 \% \pm 7.22\%$), three of which had elevated white blood-cell counts (mean value $13.54 \pm 4.54 \times 10^9/L$). Pro-BNP and myocardial enzymes were in the normal range in all patients.

Treatment process

All five patients received β -blockers to control blood pressure ($\geq 120/80$ mm Hg) and heart rate (< 70 beats/min). Drugs for pain relief and sedation were also given. Other supporting treatments were applied according to the patients' condition. All the patients received aortic repair and cesarean section following the above essential medicine treatment. The operative data for the five patients is shown in Table 2.

Based on the recommendation of Chinese experts' consensus of standardized diagnosis and treatment for aortic dissection⁹, the first patient with a gestational age of over 32 weeks, suffering from preeclampsia, underwent a cesarean section under combined spinal and epidural anesthesia first. However, she experienced a rapid elevation of blood pressure within minutes after delivery of the fetus, leading to rupture of dissection. Although a thoracotomy was performed, the patient died due to hemorrhagic shock. The newborn of this patient had no asphyxia. Based on the lessons learned from case one, the subsequent four cases underwent TEVAR first, followed by a cesarean section under general anesthesia for better control of blood pressure. Case two completed the TEVAR and cesarean section without any adverse effects on the mother or fetal outcomes. The third case chose to continue the pregnancy after TEVAR since her gestational age was only 27 weeks plus three days. The status of the mother and fetus was closely monitored by obstetricians and surgeons. However, she presented with back pain at 30 gestational weeks, and her CTA showed strip-like leakage of contrast agent into the false lumen. A cesarean section was performed at 31 weeks plus five gestational weeks following fetal lung maturation-promoting therapy. Her newborn infant had mild asphyxia (Apgar score of 7 at 1 min) but recovered well after primary resuscitation initiated immediately after delivery. The fourth case had severe preeclampsia and fetal distress before surgery. The mother

experienced a rupture of the right iliac artery during the pushing stent-graft delivery system, and the bleeding was stopped by compressing temporarily. She underwent a cesarean section and femoral iliac artery artificial vascular replacement. The newborn of case four had a 1-min Apgar score of 5 and a 5-min Apgar score of 2, and the rescue was given up eventually. With the same procedure as that of the above patient case, the fifth case also underwent TEVAR and subsequent cesarean section. The 1-min Apgar score was 5 and the 5-min Apgar score was 7 for her newborn. Unfortunately, she developed TAAD three days later. Then, she received total aortic arch artificial vascular replacement and stent elephant trunk surgery (Sun's Surgery) plus aortic valve and ascending aortic replacement and coronary transplantation (Bentall Surgery).

Four preterm live births were recorded. Neonatal death occurred in case four at a gestational age of 29 weeks plus five days, and the pregnancy was complicated by fetal distress before surgery. Neonate one and two had a gestational age exceeding 36 weeks, and Apgar scores at birth were 8 at 1 min and 9 at 5 min. Neonate three and five had a gestational age of 31 weeks and a birthweight of around 1700g. These two neonates experienced transient mild asphyxia but were discharged without any complications. During the follow-up period, routine physical examinations of four live births showed no abnormalities. Their thyroid function was within normal range on the 14th day after delivery.

Discussion

Due to the increasing incidence rate and high mortality of TBAD in pregnancy, the effective rescue procedures and surgical methods of this disease deserves more concern. To date, there is no specific guideline, and its treatment experiences are mainly based on case series or a synthesis of current published opinions¹⁰. While TEVAR has been widely used in complicated TBAD in unpregnant patients and is increasingly being utilized in pregnant patients for aortic repair, the literature lacks consensus regarding whether to conducting TEVAR first or cesarean section. The available literature exhibits divergent treatment options across different medical centers, with some authors advocating for aortic repair surgery first and others approving the priority of caesarean section to avoid the influences of radiation caused by TEVAR on the neonates¹¹⁻¹⁴. Due to the different levels of treatment and the severity of the patient's condition, it is difficult to evaluate the treatment strategies. Here, we reported clinical data from five patients with complicated TBAD in late second and third trimester. By exploring the optimal strategy for complicated TBAD in late pregnancy in clinical practice, we found that TEVAR is safe and feasible. In addition, the strategy of TEVAR first can avoid rupture of aortic dissection caused by delivery, thus improving both maternal and fetal outcomes.

Clinical implication

As is known to all, pregnancy is a risk factor for AD¹⁵. Previous studies have reported a higher incidence rate of TAAD in pregnancy than TBAD^{4, 12}. However, recent data indicates an increasing trend in the occurrence of TBAD, especially in women with pregnancy³. Consistent with this, all five pregnant patients with AD admitted to our hospital were Stanford type B in the past two years. In our study, advanced in maternal age, preeclampsia and cesarean delivery may be contributing risk factors of TBAD, which is consistent with literature reports^{16, 17}. It is recommended that patients with high risks for aortic dissection should receive transthoracic ultrasound every 4-6 weeks of pregnancy as part of routine prenatal examination¹⁸, and should be given more attention to the occurrence of AD.

Early identification and diagnosis of AD are crucial for treatment. However, the diagnosis of AD in pregnancy is challenging. The symptoms vary among patients, especially in those with TBAD, and are easily confused with physiological discomfort and other diseases during pregnancy¹⁹. Given the rarity of AD, it is easily misdiagnosed. CTA has high sensitivity and specificity in the detection of dissection²⁰. However, patients may refuse to undergo CTA due to concerns about the impact of radiation on the fetus. In fact, fetal radiation doses delivered by CT examinations are generally below the consensus levels for negligible risk (< 50 mGy)²¹. In addition, although iodinated contrast agents typically traverse the placenta, the use of contrast agents in pregnancy is considered relatively safe²². Transthoracic echocardiography (TTE) is recommended as a preliminary screening method for pregnant women complicated with AD because of its high safety and technical popularity^{12, 23}. However, only lesions near the aortic root can be detected

by transthoracic echocardiography, and missed diagnosis may occur in the diagnosis of TBAD²⁴. In our study, all five patients were diagnosed TBAD timely through CTA. Notably, not all the patients had no signs of TBAD in transthoracic echocardiography. Since cardiac Magnetic Resonance imaging (MRI) is time-consuming, we did not choose MRI before treatment. Based on our experience, CTA is the optimal examination for pregnant patients with suspected TBAD. It can not only quickly detect the existence of dissection, but also clarify the type and extent of the lesion. Moreover, CTA can show the iliac artery tortuosity and pathological changes, which is essential for selecting safest surgical approaches²⁵.

Complicated TBAD with malperfusion or rupture is considered a medical emergency and requires surgery management²⁶. In the endovascular era, new technologies are constantly emerging. TEVAR has been shown to have lower mortality and morbidity compared with open aortic repair in patients with TBAD^{27, 28}. Currently, there are limited reports on the application of TEVAR in pregnant patients with TBAD. The timing of TEVAR and cesarean section is also controversial. Considering the negative impact of cardiac surgery on fetus, a cesarean section was recommended before any surgical intervention with the mother^{19, 29}. Shu et al., reported two cases of TBAD in late pregnancy, who were successfully treated through TEVAR¹¹. They suggested that for the late third trimester of pregnancy (beyond 37 weeks gestational age), emergency intervention on the aorta should be before delivery if accompanied by the complication¹¹. In our study, the first case experienced dissection rupture during cesarean section and died unexpectedly. On the contrary, the following four patients who underwent TEVAR before cesarean section survived following successful treatment. Thus, we think that for patients with complicated TBAD in the third trimester, there is a risk of dissection rupture during delivery. This may be because of the cessation of placental circulation and an increase in cardiac blood volume after fetal delivery. Given this, performing TEVAR first may be a wise choice. Even though, this treatment method is still challenging as TEVAR may become complex in patients with late pregnancy. Due to the compression of the uterus, the stent-graft delivery system is difficult to pass through the iliac artery. One patient in our study experienced rupture of right iliac artery because of above reason. Moreover, the amount of radiation was limited for the safety of the fetus. Thus, TEVAR during pregnancy requires experienced and skilled cardiac surgeons to ensure the safety and short duration of the surgery.

Due to the small numbers reported globally, there is a lack of recorded long-term outcomes for pregnant patients with TBAD who were treated by TEVAR. The outcomes are satisfying in our series. Despite complications, such as internal leakage, iliac artery rupture, and progression to TAAD, which occurred during the treatment process, patients successfully completed TEVAR and survived. Moreover, no major late complication was detected, and a recovery of cardiac function was observed at last follow-up. Another concern for applying TEVAR in pregnancy is the safety of the fetus. It was reported that the total radiation dose during endovascular therapy and one year after surgery is lower than 50 mGy³⁰, which is within the safe range for the fetus. In addition, except for the death of one neonate with preoperative fetal distress died, three neonates survived TEVAR without any complications. It is undeniable that brief neonatal asphyxia has occurred and may worsen if the surgical time is extended. Besides trying to control the duration of surgery, other methods to ensure the safety of newborns should be explored.

Strengths and limitation

The primary strength of the study is that it has the highest number of pregnant individuals with complicated TBAD, although there are five cases. Of note, this study also has limitations. Due to the low incidence rate of TBAD, the number of cases in the study is small and comes from a single center. In addition, this study did not set up a control group. Finally, the long-term effects of TEVAR were absent. To further elucidate the role of TEVAR in complicated TBAD during pregnancy, more cases with long follow-ups are needed.

Conclusion

Complicated TBAD in late pregnancy is a rapid onset and severe disease that endangers the lives of both mother and fetus. Pregnant women with increased blood pressure during pregnancy should be on the alert for AD. Once obvious chest pain occurs, CTA should be performed to avoid missed diagnosis and time

consumption. The management of these patients requires a multidisciplinary team, but the best course of action remains debatable. Patients treated with TEVAR in this series revealed satisfying short-term and midterm outcomes, providing a promising treatment option for complicated TBAD in late pregnancy. Considering the priority of maternal safety and the relative safety of TEVAR for the fetus, we recommend that TEVAR can be performed before the delivery of newborns. Specifically, for patients in the third trimester, a single-stage delivery combined with thoracic endovascular aortic repair is the preferred approach, and TEVAR should be conducted prior to cesarean section. As for patients in the second trimester, pregnancy can be continued if conditions of the mother and the fetus are comprehensively evaluated and intensely monitored.

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